Utah Renewable Energy Business Summit

November 15, 2015

Mike Saunders

Project Manager – Resource Development

PACIFICORP ENERGY
A DIVISION OF PACIFICORP

PacifiCorp

- Supply and distribute electric energy in six western states: California, Idaho, Oregon, Utah, Washington, and Wyoming
  - **PacifiCorp Energy**: Generation, Mining and Commercial & Trading
  - **Rocky Mountain Power:** Transmission & distribution services in Idaho, Utah, and Wyoming
  - **Pacific Power**: Transmission & distribution services in California, Idaho, and Oregon
  - **Renewable Energy Portfolio**
    - Approximately 3,100 Megawatts or 22% of PacifiCorp's generation capacity is from renewable or non-carbon sources.
      - 11% from hydroelectric
      - 11% from Wind and Other Renewable Energy Sources

PacifiCorp – Geothermal Energy

- Geothermal Energy
  - –Blundell Geothermal Plant, Milford, Utah
    - Unit 1 – Single Flash facility, Capacity 23 Megawatts
    - Commissioned in1985
    - Unit 2 – Binary facility, Capacity 11 Megawatts
    - Commissioned in 2006
    - Geothermal Resource – Roosevelt Geothermal Hot Springs
    - Unit 3 – In Development, Capacity estimated at 35 Megawatts

•Identifying & Developing a Viable Resource

- Resource Exploration
  - –What is the surface and sub-surface history of the potential resource?
  - –Surface Activities
    - Micro-Gravity Surveys & Seismic Surveys
  - –Sub-Surface Activities
    - Drilling
      - – Exploratory Boreholes
        - » Small diameter borehole used to measure resource temperature and pressure.
        - » Cost ~$200,000 - $800,000
      - – Production Well
        - » Large diameter well for flow measurements and generation
        - » Cost ~$700 - $1,000 per foot
        - » Example: Production well drilled in 2008 cost $4.5 Million
      - – Injection Well:
        - » Large diameter well for disposing of geothermal fluid back into the resource area.
        - » Cost ~$700 - $1,000 per foot

Identifying & Developing a Viable Resource

- Resource Classification
  - –High Enthalpy
    - Resource fluid temperature > 300°F
    - Ideally suited for flash plant technology
  - –Low Enthalpy
    - Resource fluid temperature < 300°F
    - Ideally suited for binary plant technology
- Resource Size & Geophysical Characteristics
  - –How much geothermal fluid be withdrawn without depleting the resource?
  - –How much energy can be withdrawn from the geothermal fluid without cooling the resource?

Identifying & Developing a Viable Resource

- Other Resource Development Issues
  - –Identifying the risks
  - –Quantifying, reducing or mitigating the risk in order to receive funding
  - –Chemical composition of the geothermal fluid and how will it affect the facility design
  - –Geothermal fluid injection capacity
  - –Injection wells connection to the geothermal resource
  - –What is the transmission access?
  - –Is there a viable interconnection/ transmission point nearby?
  - –Is the project economically viable?
  - –Available economic incentives (Federal and State)
  - –Property ownership (Federal, State, Private)

Regulations & Permitting

- Permitting Agencies
  - –Federal
    - Department of the Interior
      - –Bureau of Land Management
      - –Minerals Management
  - –State
    - Department of Environmental Quality
    - Department of Water Rights
    - Department of Water Quality
    - Local County and Cities
    - School and Institutional Land Administration

- Permitting Considerations
  - –Habitat Disturbance
  - –Visual Impacts
  - –Cultural/Historical Resource Impacts
  - –Air Emissions
  - –Water Rights
  - –Wastewater Discharges
  - –Noise
  - –Land Use Compatibility
  - –Potential Ground Water Quality Impacts
  - –Drill Permits
  - –Construction Permits
  - –Leasing
  - –Royalty Payments

Risk Assessment

- Resource Risk
  - Depletion
  - Cooling
- Drilling Risk
  - Dry Well
  - Non-Commerical Well
- Production Risk
  - Short Term
    - Start-up
    - Commissioning
  - Long Term
    - Reservoir depletion
    - Production drop-off
    - Well life
    - Reservoir changes
- Economic Risk
  - Capital
  - O&M
  - Transmission
  - Material
  - Construction
- Environmental Risk
  - Emissions
  - Wildlife
  - Water
  - Waste

Costs, Risks & Funding

- Funding
  - –Regulatory Cost Recovery
  - –
- Exploration Phase
  - –Reservoir Engineer
  - –Drilling & Support Equipment and Personnel
  - –Geologist
  - –Testing Equipment
  - –Permitting
- Development Phase
  - –Reservoir Engineer
  - –Drilling & Support Equipment and Personnel
  - –Owner's Engineer
  - –Testing Equipment
  - –Permitting
- Construction phase
  - –Engineering
  - –Transmission
  - –Construction
  - –Permitting
  - –Commissioning
  - –Operation
  - –Reporting


PACIFICORP ENERGY
A DIVISION OF PACIFICORP

Geothermal Exploration and Confirmation

An Overview of
Strategy and Estimated Costs

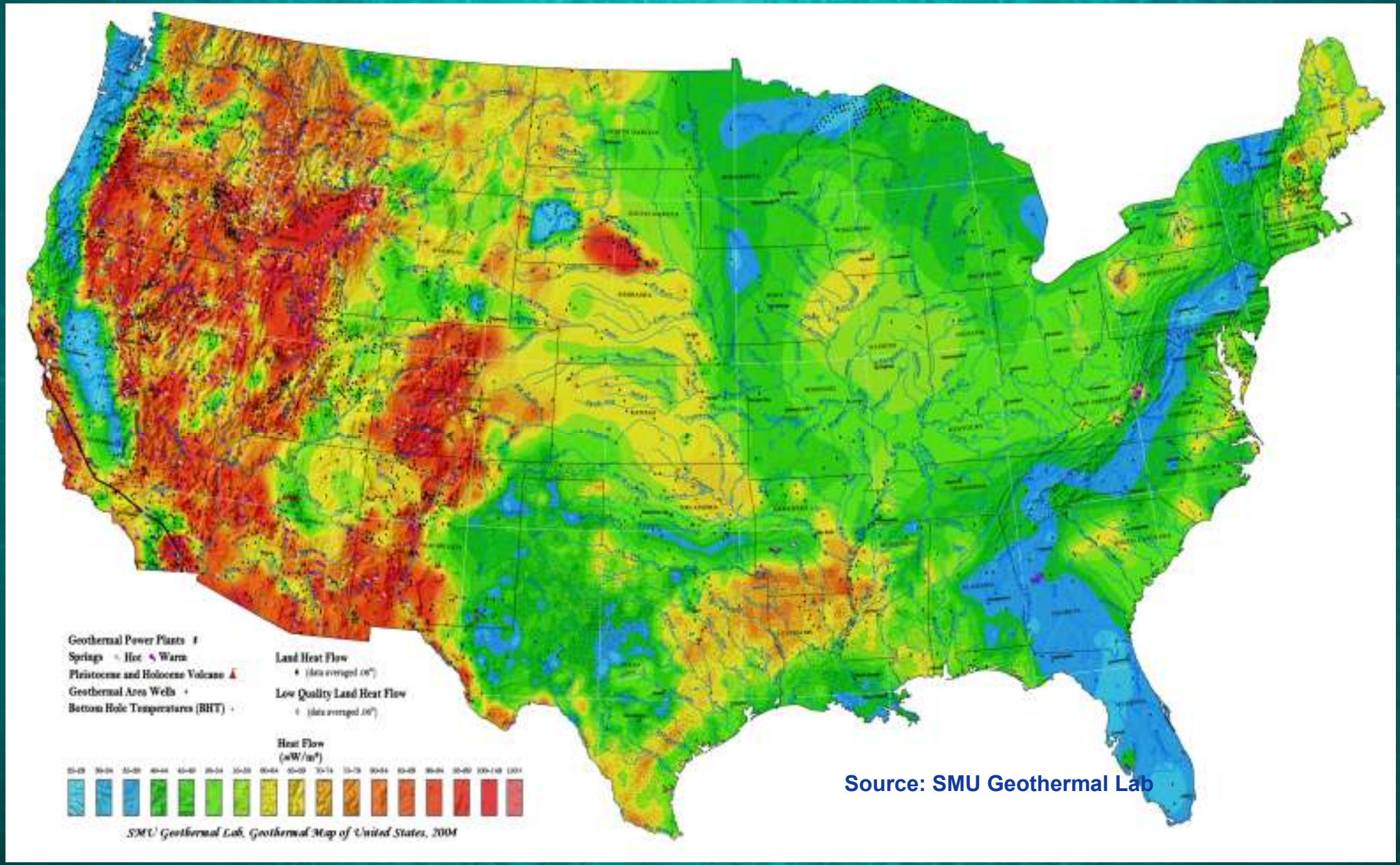
Utah Geological Survey

- Role in renewable and energy efficiency markets
  - Geothermal resource information in Utah (http://www.geology.utah.gov/)
  - Cooperate with state/federal agencies for geothermal resource assessments
  - Utah State Energy Program (http://geology.utah.gov/sep/)
- Experience:
  - "Thermal Waters in Utah" by H.D. Goode (1978) [32 years experience within UGS]
  - Staff expertise: R. Allis, R. Blackett, M. Gwynn
  - Notable project: NGDS through AASG/AZGS

Utah Geological Survey Geothermal Program Contact

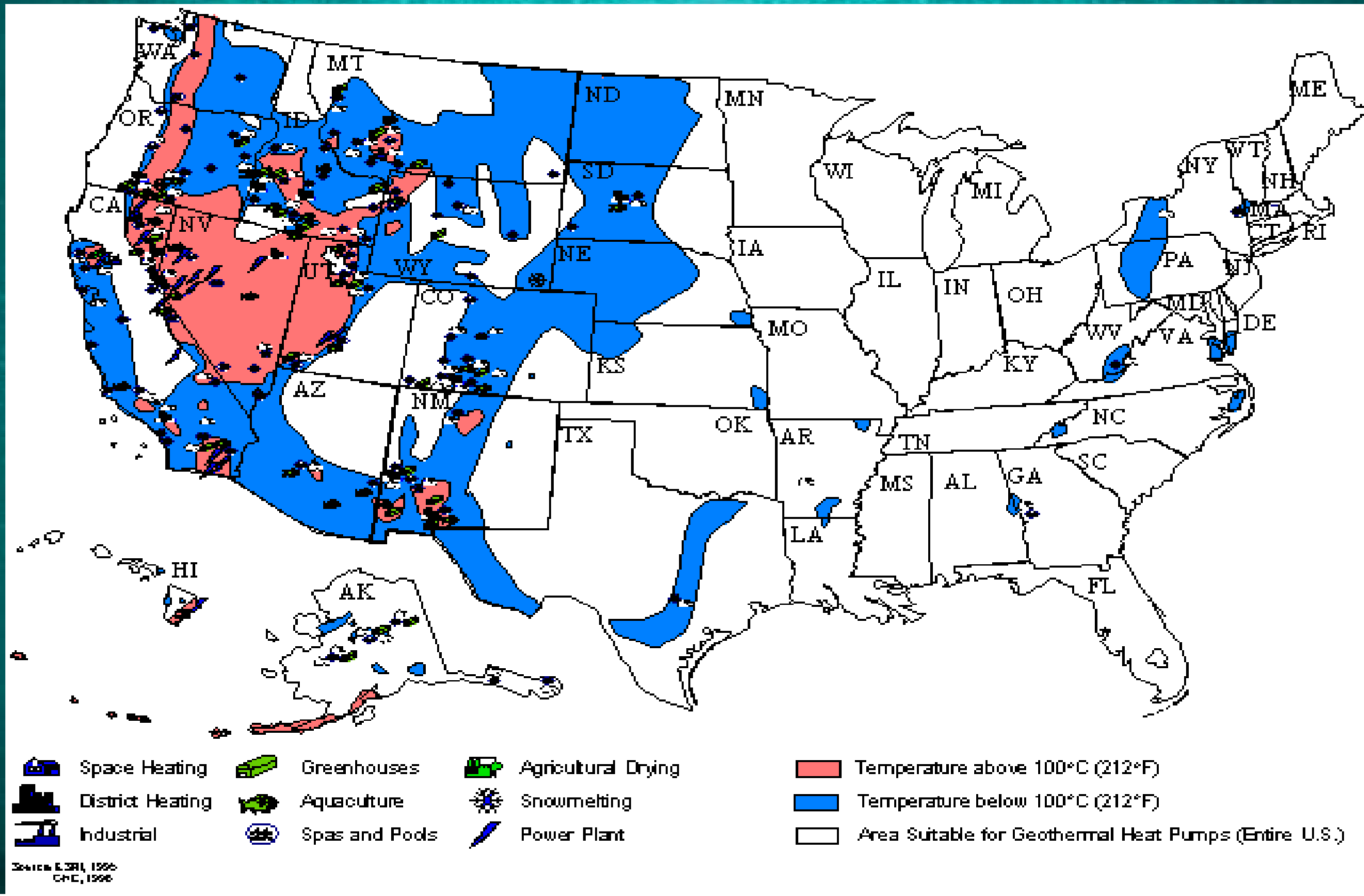
Robert Blackett
robertblackett@utah.gov
435-865-9035; 801-537-3300
http://www.geology.utah.gov
88 E Fiddler Canyon Rd., Cedar City, UT 84721 (southern regional office)
1594 W North Temple, SLC, UT 84114-6100 (main office)

Heat Flow in the Conterminous U.S.

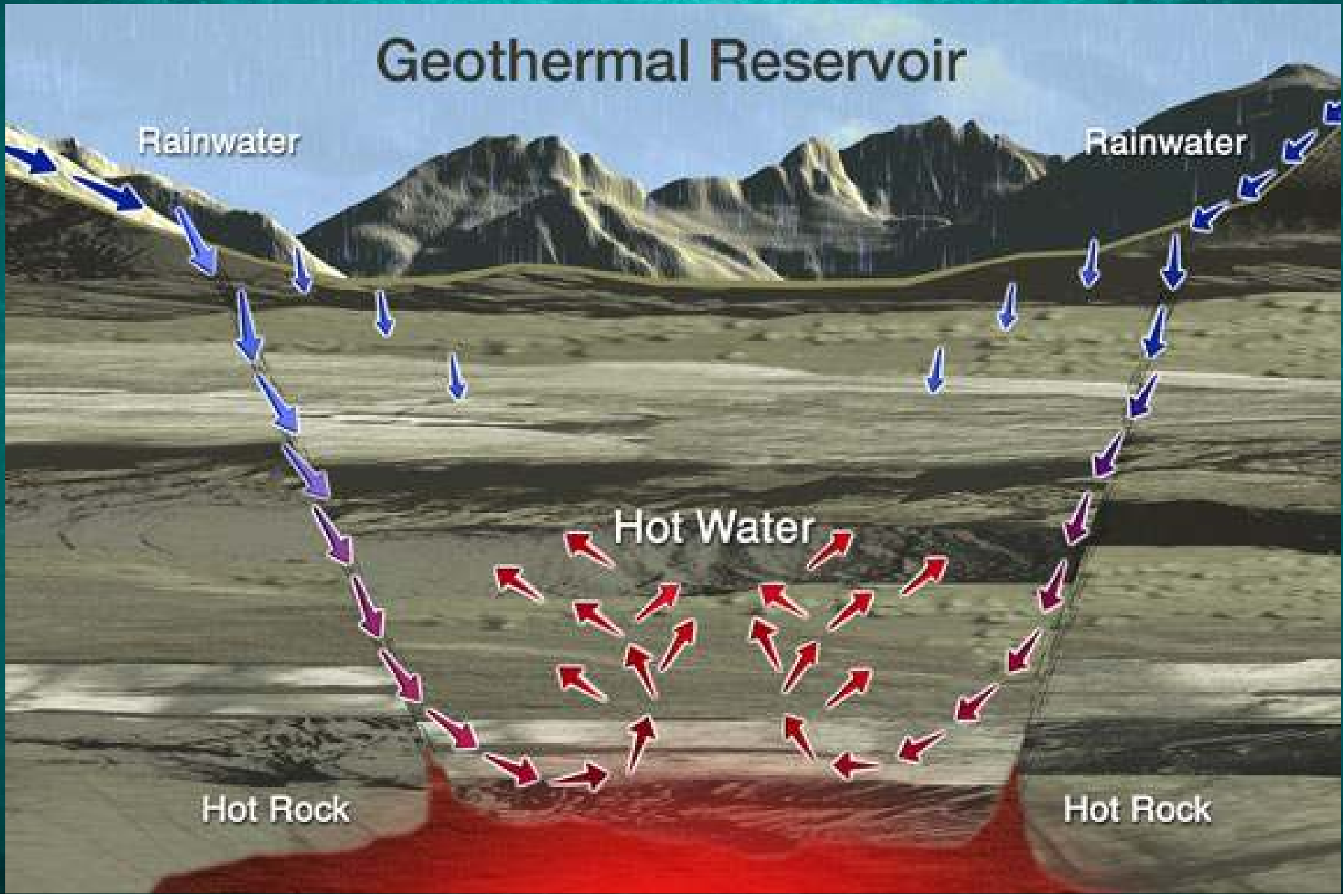


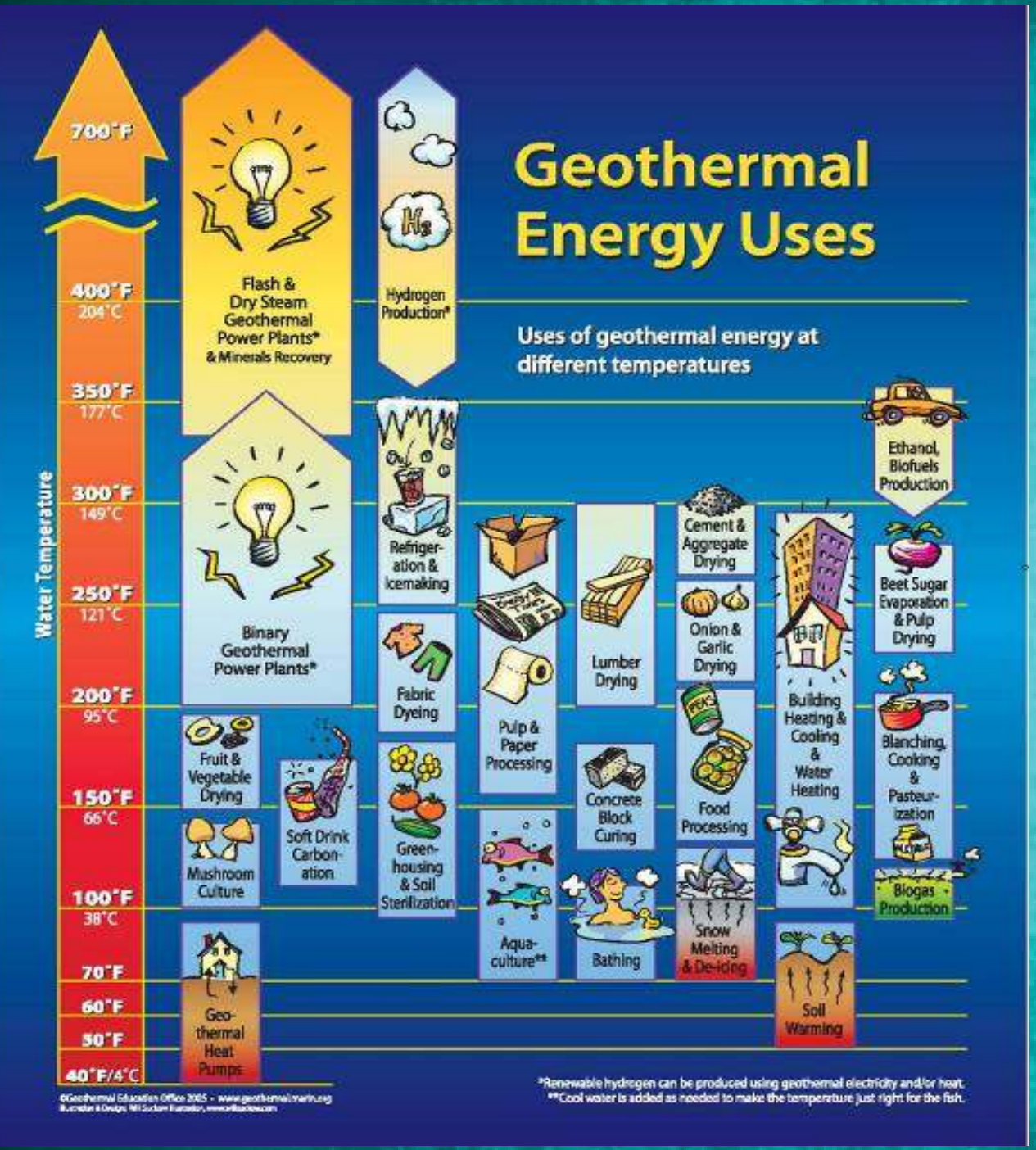
Source: SMU Geothermal Lab

U.S. Geothermal Projects and Resource Areas



Hydrothermal Convection





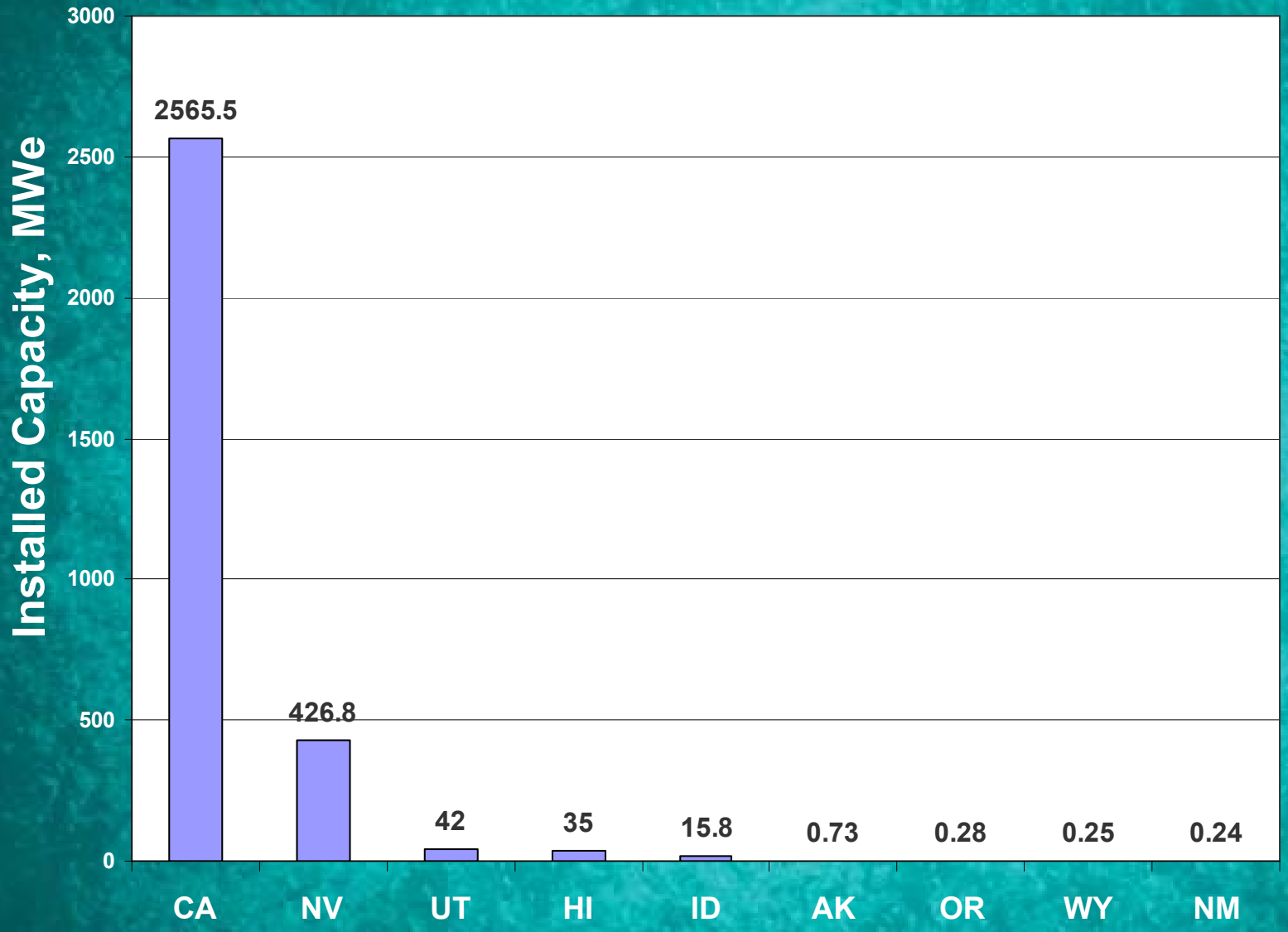
Geothermal Education Office

http://www.geothermal.marin.org/

GEO
GEOTHERMAL EDUCATION OFFICE

1-800-866-4436
http://geothermal.marin.org

U.S. Geothermal Electric Power Capacity by State



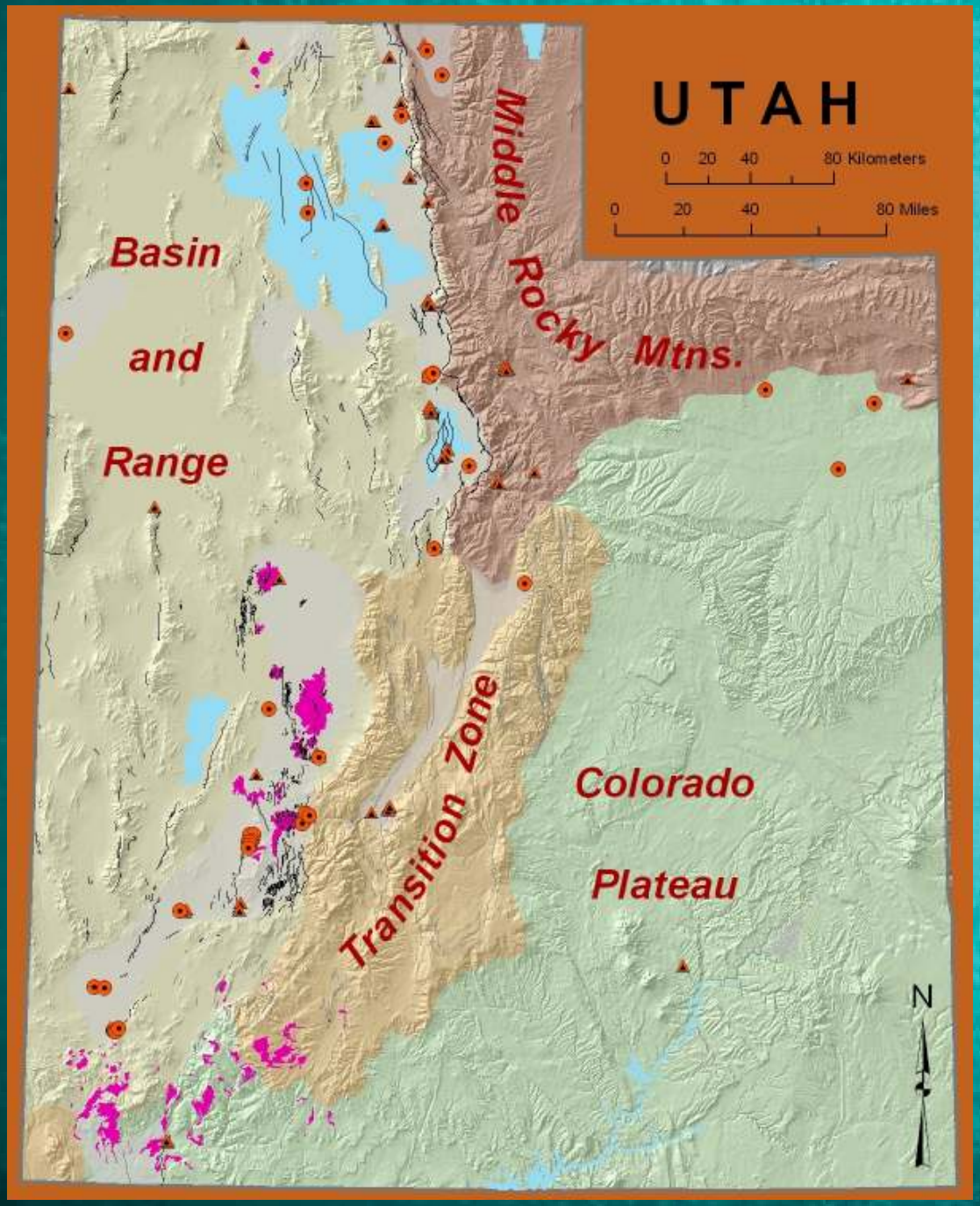
Source: GEA April 2010

U.S. Geothermal Direct Use

Use	# of Installations	Installed Capacity (MWt)	Annual Energy Use 10^9Btu	Annual Energy Use TJ	Capacity Factor
Space Heating	1000	90	900	948	0.33
District Heating	18	105	628	662	0.20
Aquaculture	45	140	2,910	3,067	0.70
Greenhouses	37	129	1,164	1,227	0.30
Agriculture Drying	3	20	290	305	0.49
Industrial Processing	4	7	72	76	0.34
Resorts/Spas/Pools	219	107	2,370	2,498	0.74
Snow Melting	5	2	16	17	0.27
Subtotal	1,331	600	8,350	8,800	0.47
Geo. Heat Pumps	450,000	3,400	12,250	12,900	0.12
Total		4,000	20,600	21,700	0.17

Source: OIT-GHC

Geothermal Resources in Utah

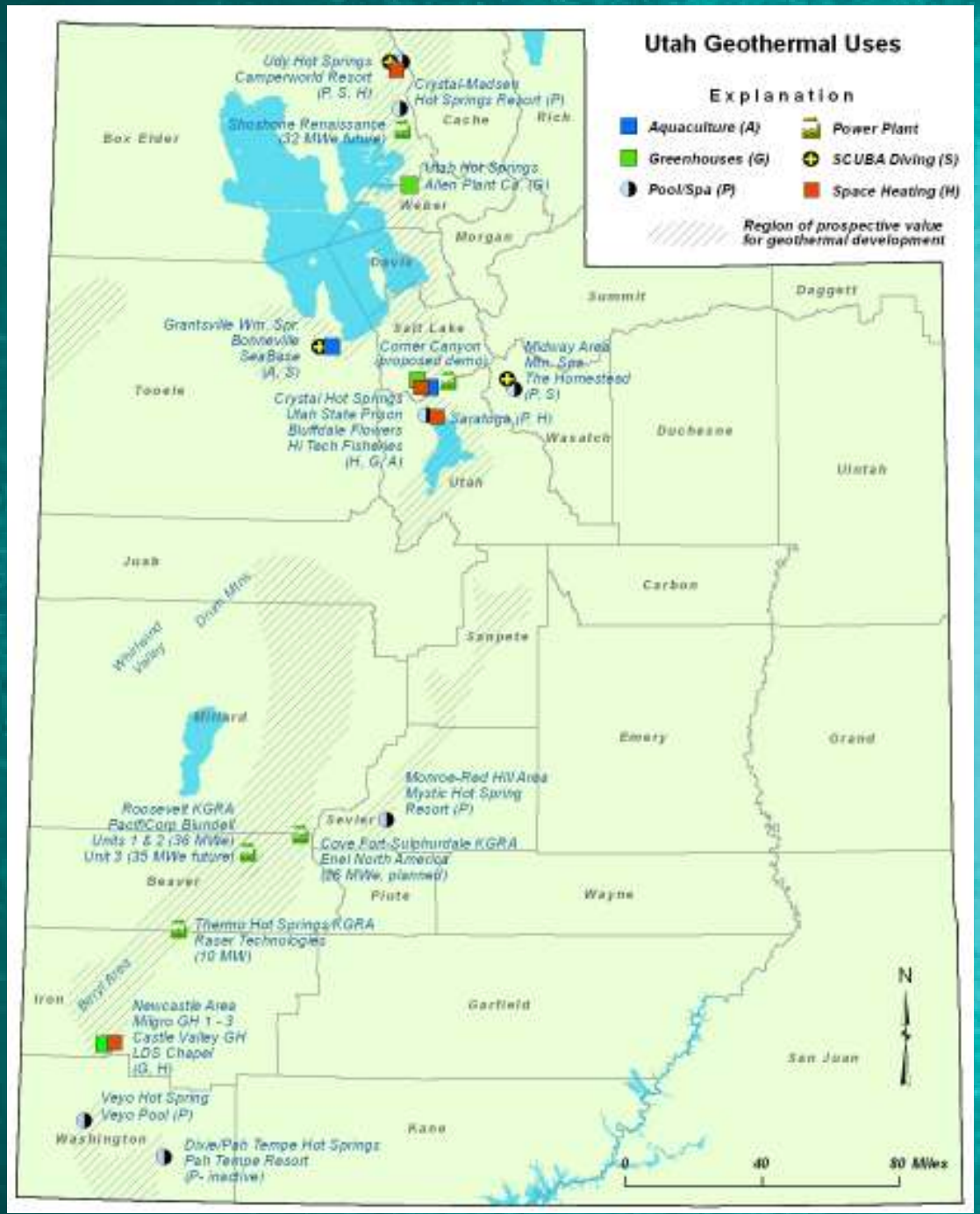


Main Resource Areas Include:

Basin and Range – Escalante Desert, Black Rock Desert, Sevier Desert, Wasatch Front Valleys

Transition Zone – Tushar Mtns., Sevier Valley, St. George Basin

Rocky Mtns. - Heber Valley, Cache Valley



Utah Geothermal Uses

- *1100 identified geothermal sources, wells & springs > 20°C [68°F]*
- *23 direct-use sites*
- *3 power-generation sites*

High-Temperature Hydrothermal Exploration

- –Homework
- –Literature search, data compilation
- –Satellite Imagery, low-altitude aerial photography, GIS development
- –District Reconnaissance (~1200 mi^2)
  - •Water sampling, analyses (chemical, isotopic data from springs/wells)
  - •Initial field mapping at 1:62,500 (1” ~ 1 mile)
  - •Thermal gradients, available boreholes
- –Prospect Mapping at 1:24,000 (1” = 2,000 ft)
- –Prospect Evaluation
  - •Temperature-gradient/exploratory hole drilling
  - •Trace element zoning, fluid geochemistry, hydrology
  - •Lithology, alteration, mineralogy
  - •Temperature measurements
- –System Modeling, conceptual

Source: Hance, C.N., GEA

High-Temperature Hydrothermal Exploration

- **Prospect Delineation**
  - **Detailed mapping at 1:6,000 (1” = 500 ft)**
  - **Electrical geophysical surveys**
- **System Modeling, numerical & conceptual**
- **Model test drilling**
- **Geochemistry (isotopes), hydrology**
- **Lithology, alteration mineralogy**
- **Geophysical logging**
- **Reflection seismic and/or AMT-MT**
- **Detailed numerical, conceptual model**
- **Production test drilling**
- **Geochemistry (isotopes), hydrology**
- **Lithology, alteration mineralogy**
- **Geophysical logging**
- **Reservoir model from reservoir engineering**
- **Feasibility study**

- **Source: Hance, C.N., GEA**

High-Temperature Hydrothermal Exploration Costs

Authors:	*Exploration cost*
Nielson (1989)	107 $/kW
EPRI (1996)	126 $/kW
EPRI (1997)	101 - 130 $/kW
GeothermEx (2004)	89 - 42 $/kW

Source: Hance, C.N., GEA

Confirmation* Unit Costs

Method	Unit	Cost per unit ($)
Administration costs	*project*	*7.5 % of total confirmation*
Drilling : Full diameter hole	*foot*	*Cost = 240,000 + 210 (ft) + 0.019069 (ft)^2*
Drilling : Unsuccessful hole	*%*	*40%*
Other	*project*	*20,000*
Regulatory Compliance	*project*	*5 % of drilling*
Reporting document:	*project*	*5 % of drilling*
Well Test: Full dia., 3-10 days	*well*	*70,000*
Well Test: Multi-well, 15-30 days	*project*	*100,000*

*Production wells and their testing

Source: Hance, C.N., GEA

FOR MORE INFORMATION

U.S. Department of Energy
Geothermal Energy Program
www1.eere.energy.gov/geothermal

GEO-HEAT CENTER
Oregon Institute of Technology
www.geoheat.oit.edu

Geothermal Education Office
Collaborative publications & outreach
www.geothermal.marin.org

Geothermal Resources Council
International geothermal community
www.geothermal.org

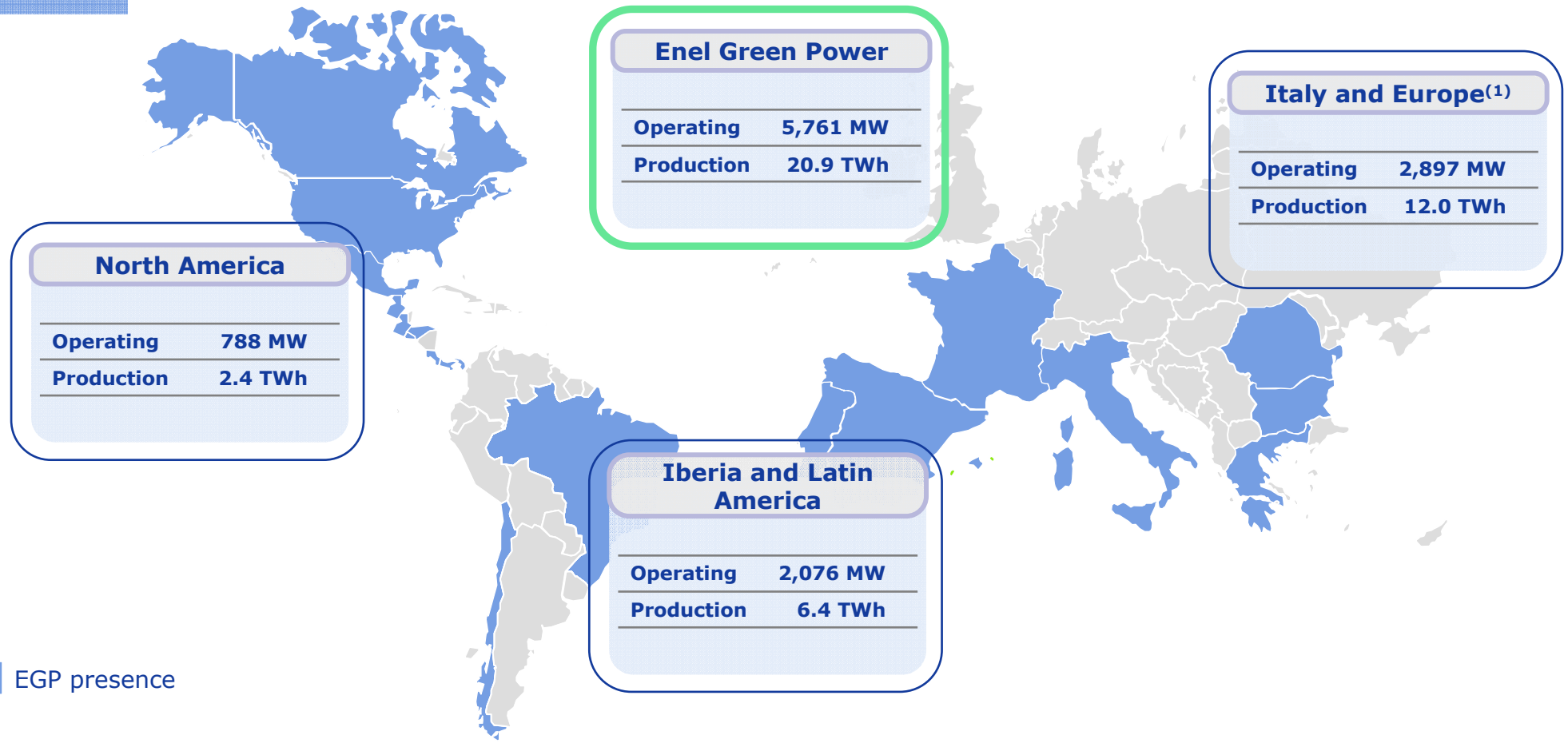
Geothermal Energy Association
U.S. trade association
www.geo-energy.org

Mr. Daren Daters
Compliance Manager
Enel North America

- Responsible for all permitting and regulatory compliance for ENA's North American geothermal division.
- Has been in the energy industry for the last 18 years.
- Has been involved in many aspects of the geothermal business from power plant operations and management, Regulatory and Compliance, Project Development and Business Development.
- Has played a key role in working with Local, State and Federal Agencies such as US Forest Service, Bureau of Land Management and Bureau of Reclamation.
- He has worked very close with these agencies in Nevada, Utah and California and is well versed in the NEPA and CEQA processes.

Global Leader in a Growing Industry

EGP global footprint – H1 2010



Footprint in 16 countries
across all main renewable technologies

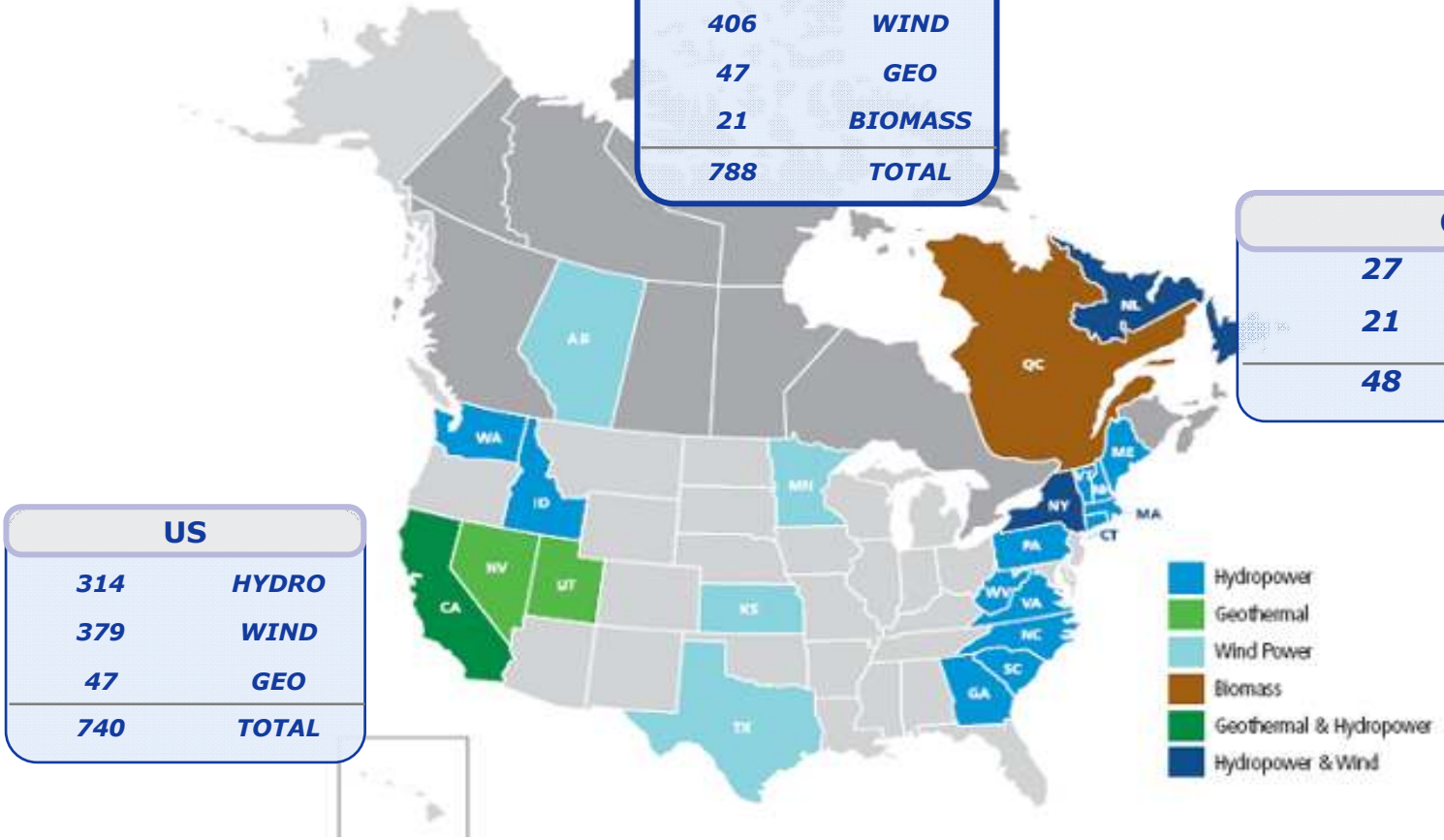
The North American Area

Assets overview

NORTH AMERICA	
314	HYDRO
406	WIND
47	GEO
21	BIOMASS
788	TOTAL

CANADA	
27	WIND
21	BIOMASS
48	TOTAL

US	
314	HYDRO
379	WIND
47	GEO
740	TOTAL



Balanced presence in main renewable technologies in US States and Canadian Provinces

Project Developement

1. **Land Control**
   - **Private or Federal**
2. **Transmission**
   - **Line location. Available Capacity.**
3. **Resource Evaluation**
   - **Green Field. Brown Field. Existing Field.**
4. **Permitting**
   - **Local. State. Federal.**
5. **Power Purchase Agreement (PPA)**
   - **Utilities willing to buy the power.**
6. **Financing**
7. **Development**

Contact Information

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Reno, Nevada 89502

Disclaimer!

I ain't no geothermal expert…

Renewable Development

Benefits

- Assessed Valuations
- Jobs
- Infrastructure

Land Use Planning

- Managing Public Opinion

Taxes

First Wind & Raser

- Values—Before
- $557,349 assessed valuation
- $20,200 annual tax collections

Values—After

- $360 million in assessed valuation
- $3.6 million in tax collections

Jobs Created

First Wind

- Construction Phase 200 +/-
- Ongoing 25

Raser

- Construction 150 +/-
- Ongoing 8 to 10

Key Ratios

Capital Investment per Job Created

- First Wind $12 million per job
- Raser $5 million per job

The Community…

Understand the Motivations

- Jobs
- Taxes

Know the Land Use Ordinance

- Special Zone Classification
- Conditional Use Permit

Know the geography

Permitting

- State, Federal & Local
  - » Be sure to understand who does what.

Things to consider…

Most rural communities have natural resource based economies.

- With all that comes with it.
- Even though these are green technologies, don't expect the everyone to fall in love with you.

Most rural communities have newcomers

- Urban refugees.
- Potential friction.

The NIMBY Crowd

New Harmony
vs.
Milford

Remember…

Most communities are ecstatic to have you in their midst…

raser®

TECHNOLOGIES

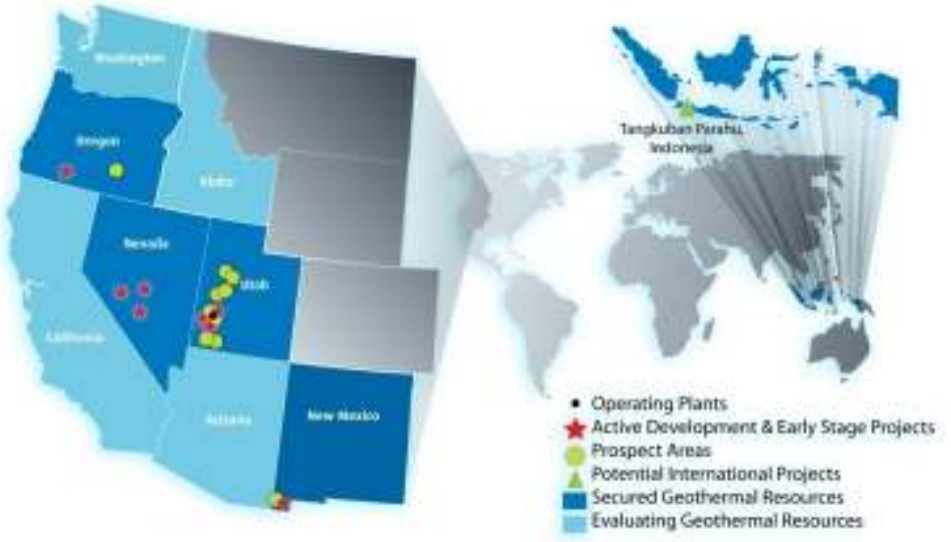
RENEWABLE POWER GENERATION

Steven Brown – Raser Technologies

- Executive Vice President, Responsible for project development, permitting, engineering, construction and operations.
- Background in start-up of technology based companies and project management of complicated and diverse projects in energy, mining, and public works.
- 25 years in energy project development, and tax related project financing.
- Bachelor of Science in Civil Engineering and Masters of Business Administration from Brigham Young University.

Raser Technologies

- Utah based renewable power developer / operator
- Thermo binary geothermal power plant – Beaver County
- Lightning Dock geothermal project Hidalgo County, New Mexico
- Thermo PV solar project – Beaver County
- 275,000 Acres 8 projects, 10 prospects



Development Issues

Geothermal Drilling Risk

- Initial resource development risky / expensive
- 25 to 50% proven before long term finance
- Resource development work expensive

Transmission Issues

- Interconnection process lengthy / expensive
- System upgrades surprises
- Down payments / contractual commitments

Power Purchase Agreement

- California markets like base load power
- Utilities have become more selective
- Contractual financial commitments / resource risk

Observations

Teaming / Partner

- Resource development cost
- Partner brings additional development experience
- Partner spreads risk over multiple projects

Base load Versus Intermittent

- ISO managers pushing back on intermittent suppliers
- PPA's starting to require firming power
- Energy storage the solution?

Energy/Tax Policy

- Federal political uncertainty is delaying projects
- State politics pushing back against renewables
- Unified lobbying effort solar/wind/geothermal?

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TECHNOLOGIES

RENEWABLE POWER GENERATION